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E82-10074
CR-165096

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle
Dryland Pasture and Crop
Conditions as Seen by HCMM

5. Report Date
April 1981

6. Performing Organization Code

7. Author(s) W. D. Rosenthal, J. C. Harlan (P.I.) and
B. J. Blanchard

8. Performing Organization Report No.

9. Performing Organization Name and Address
Remote Sensing Center
Texas A&M University
College Station, Texas 77843

10. Work Unit No.

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
Goddard Space Flight Center
Greenbelt, Maryland 20771

13. Type of Report and Period Covered
Type III Final Report
January 1978 - January 1981

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract The main objective of this study was to relate antecedent precipitation index (API) to surface temperatures as measured from the NASA C-130 and HCMM (Heat Capacity Mapping Mission) thermal data. Significant results from the aircraft flight in May 1978, include 1) canopy temperature were measured accurately remotely, 2) pasture surface temperatures were related to pasture and wheat soil moisture conditions, 3) no relationship was developed with that data set between wheat yield and thermal infrared data due to a lack of moisture stress during the measurement period, and 4) lake surface temperatures were useful in normalizing the thermal IR data. Results from HCMM also suggested a relationship between thermal IR data and antecedent precipitation index. Day/night surface temperature differences obtained from HCMM over the watershed in October 1978 was strongly related (R^2= 0.76) to API for approximately a seven-day period after the storm. Day/day surface temperature differences from data collected before and after a storm in July 1978, were also strongly related (R^2= 0.68) to API for a seven-day period after the storm API estiamtes using day/night and day/day surface temperature differences were equally accurate for the same period after the storm. In conclusion, HCMM proved to be adequate in detecting relative soil moisture differences; but the overpass timing was infrequent and prevented detailed analysis of the API/thermal relationship.

17. Key Words (Selected by Author(s))
Antecedent Precipitation Index, HCMM, Pasture, Wheat, Soil Moisture Stress, Surface Temperature Differences

18. Distribution Statement

RECEIVED
APR 27 1981
SIS/902.6

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	53	HCM-049

Type III
Final

*For sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

(E82-10074) DRYLAND PASTURE AND CROP CONDITIONS AS SEEN BY HCMM Final Report, Jan. 1978 - Jan. 1981 (Texas A&M Univ.) 8 p HC A02/MF A01 CSCL 08F

N82-20597

Unclas
G3/43 00074

Enclosure

APPENDIX A

EXPLANATIONS AND ERRATUM

One aspect not discussed in great detail is the low emissivity in the pasture field of E-6 and bare field of E-9. Both sites had lower ground cover compared to the other pasture sites--sites E-6 and E-9 had gound cover of approximately 40% and 5%, respectively. Other pasture sites had approximately 70-90% ground cover. Moisture contents were quite high at all sites so no definite moisture effect on emissivity could be noted from the data collected. Consequently, the lower emissivity is likely due to less ground cover at E-6 and E-9.

Tables 3 and 4 have been modified to clarify information. Table 3 has been modified by ordering the the entries by crop type rather than by flight line (Table 3). Table 4 has been eliminated, but the information contained in Table 4--the listing of rain gage sites eliminated due to the surrounding 1 sq km area having less than 60% pasture--has been incorporated into Figure 10.

In addition Figure 5 and 12 were briefly discussed in the report. Both figures were used to display the general relationship between day/night temperatures and API. A high temperature difference implies lower soil moisture and API. In addition, it appears that soil type differences yield different responses. One must be careful of making incorrect judgements because on many cases API ranges are higher in the loamy soil compared to the sandy loam or clay loam soil. The caption for Figure 12 should also say "API" rather than "API conditions". In addition, the transects in Figures 20 and 21 were in one soil type--loam. As a result, temperature variations are due to moisture or land use differences. On July 24, soil moisture differences dominated variation in the thermal response; on July 29, land use differences dominated the response.

ANTECEDENT PRECIPITATION INDEX (API)

DESCRIPTION

It should be re-emphasized that equation (1) on page 4 is an empirical relationship developed for vegetative and topographic conditions in the Washita River Watershed. The equation was modified from the Kohler and Linsley (1951) model of soil moisture depletion:

$$API_i = API_0 k^t \qquad (2)$$

where API_i is the API on a given date i, API_0 is the initial value of antecedent precipitation index, k is a depletion factor, and t is the number of days after the initial date. Any value may be input as an intial API, but within a few weeks API approaches the true API value. In our study the initial value was 2.54 cm on January 1, 1978. Modification of equation (2) can give equation (3)

$$API_i = API_{i-1} * k \qquad (3)$$

where API for any day i is equal to the API for the previous day multiplied by a factor k. Equation (3), however, does not take into account precipitation. Effective precipitation--precipitation that infiltrates into the soil--is accounted for the by the term $P^{0.829}$, where P is the daily precipitation amount (cm). The constant was also empirically developed for soil, vegetative and topographic conditions in the Washita River Watershed area. Other watershed may likely have a different constant.

In addition to Kohler and Linsley (1951) using API to model runoff for a given storm, other hydrologists have used API. Papadakis and Pruel (1973) calculated f_0 and k in Horton's infiltration model (1940) from API. Alikhan et. al. (1972) used API as an input into a prediction model of low stream flows. With such uses of API in

hydrology, several API estimation techniques, such as utilizaton of remotely sensed data have been tested. McFarland (1975) has related Skylab L-band brightness temperatures with antecedent precipitation index for a given region. Given the good results estimating API from passive microwave data, we felt that satellite thermal infrared data would do as well and be able to better define high moisture areas too small to be seen on passive microwave data.

ADDITIONAL REFERENCES

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McFarland, M. J. 1975. Correlation of Skylab L-band brightness temperatures with antecedent precipitation. Bull. of Amer. Met. Soc. 56:1323.

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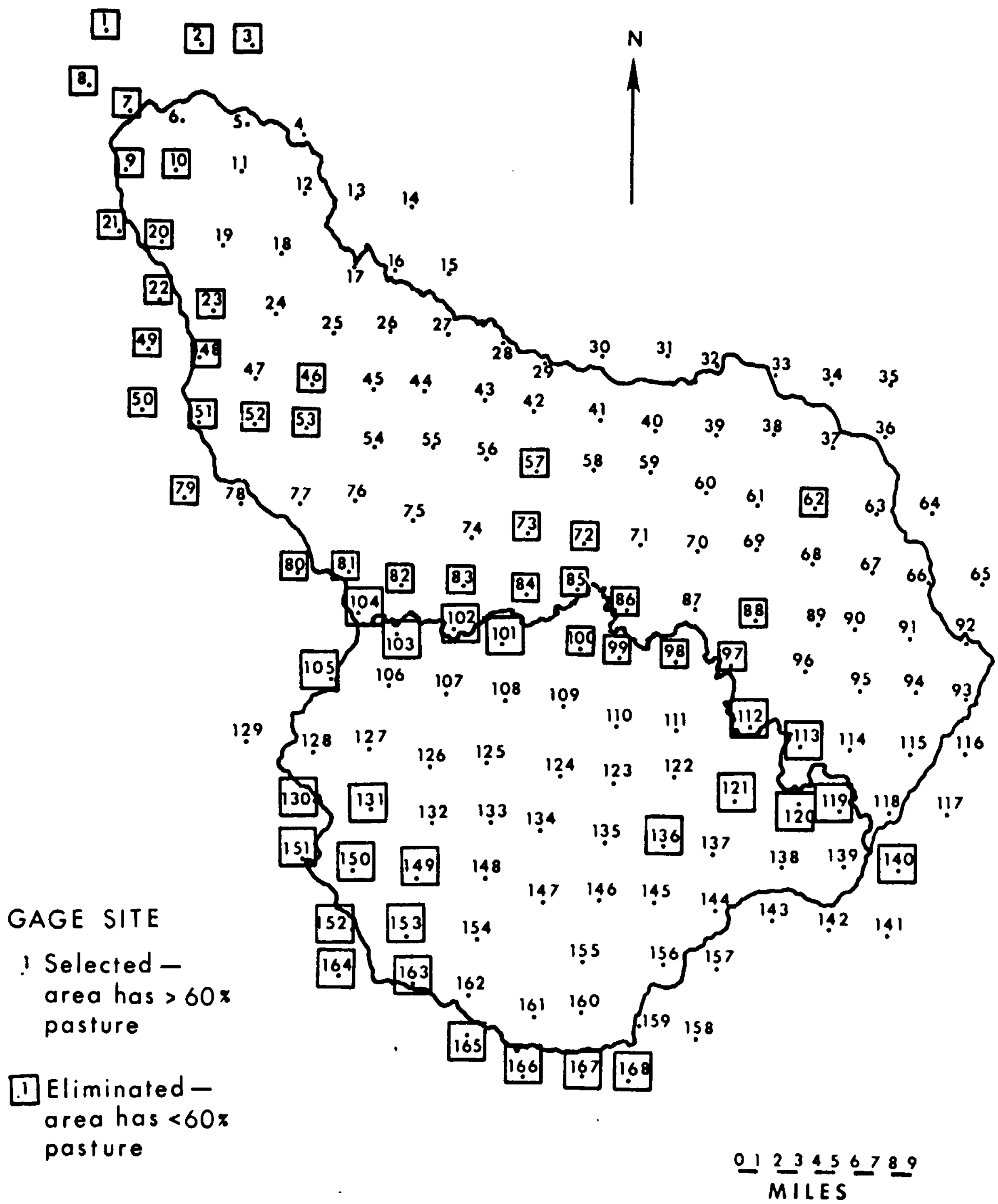
TABLE 3. DAY/NIGHT SURFACE TEMPERATURE DATA

Site	Day Temp.	Night Temp.	Day-Night Diff.
E-2 (oats-pasture)	27.96°C	15.98°C	11.98°C
E-3 (pasture)	30.31°C	16.12°C	14.19°C
E-6 (pasture)	30.49°C	16.68°C	13.81°C
E-9 (bare)	32.06°C	15.11°C	16.95°C
E-10(pasture)	32.90°C	16.05°C	16.85°C
W-1 (pasture)	31.81°C	15.57°C	16.24°C
W-2 (pasture)	34.01°C	15.44°C	18.57°C
W-4 (pasture)	33.26°C	15.74°c	17.52°C
E-1 (wheat)	25.06°C	17.32°C	7.74°C
E-4 (wheat)	25.52°C	16.96°C	8.56°C
E-5 (irr. wheat)	24.33°C	15.77°C	8.56°C
E-7 (wheat)	23.33°C	17.25°C	6.08°C
E-8 (wheat-grazed)	27.26°C	16.46°C	10.80°C
E-11(wheat)	27.82°C	17.11°C	10.71°C
W-3 (wheat)	24.92°C	16.31°C	8.61°C
W-5 (wheat)	25.64°C	16.04°C	9.60°C
Lake	20.61°C	22.42°C	-1.81°C



WASHITA WATERSHED RAINGAGE SITES